FLOOD PLAIN MANAGEMENT STUDY

COLD CREEK
BRANCH COUNTY, MICHIGAN

NOVEMBER 1991

prepared by:

U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan

in cooperation with:

Michigan Department of Natural Resources

Coldwater Township, City of Coldwater, Girard Township

Branch County Road Commission

Branch County Soil Conservation District

United States
Department of
Agriculture

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FOREWORD

This report defines the flood characteristics of Cold Creek, County Drain No. 15 and the Lower Lake Chain, consisting of Morrison Lake, Craig Lake and Coldwater River above Hodunk Dam located in Coldwater and Girard Townships, Branch County, Michigan. A limited amount of development exists within the identified flood plain and more is expected in the future unless local officials regulate the use of this natural hazard area.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degrees of major flooding that may occur in the future. These floods, the 10-year, 50-year, 100-year and 500-year, are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Over 8.7 miles of high water profiles along Cold Creek and County Drain No. 15 are included in Appendix A. These profiles show the expected flood elevations and water depths relative to the stream bed and flood plain. The 100-year and 500-year potential floods around the Lower Lake Chain are further defined by flood hazard area photomaps, also included in Appendix A, that show the approximate areas that would be flooded.

The flood hazard area photomaps and high water profiles included in this report are based on the natural conditions of the basin, stream and valley that existed in 1991 when this report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Technical documentation for this study is on file with the Soil Conservation Service, U.S. Department of Agriculture, 1405 South Harrison Road, East Lansing, Michigan 48823 (telephone (517) 337-6612) and the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

Assistance and cooperation of the U.S. Geological Survey, Branch County Soil Conservation District, city of Coldwater, Coldwater Township, Girard Township, Branch County Road Commission and Michigan Department of Natural Resources in the preparation of this report is greatly appreciated.

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COLD CREEK

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INTRODUCTION

The flood plains of rivers, lakes and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. Floods are acts of nature which cannot be wholly prevented by man. Therefore, the long-term solution to reduce flood damage and loss of life is to keep the flood plain void of development which could be damaged or which could obstruct the conveyance of flood waters. There are three basic actions which can be used to assure that flood plain areas are kept open:

1. Provide information to make lending institutions and prospective property buyers aware of the flood hazards.

2. Use flood plain regulations to assure that the development of the flood plain occurs in such a manner that there is no increase in flood damages to both current and future development during a flood event.

3. Acquisition of flood-prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread and, consequently, the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to be effective in the planning, development and use of flood plains, it is necessary to:

1. Develop appropriate technical information and interpretations for use in flood plain management.

2. Provide technical services to managers of flood plain property for community, recreational, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in the flood plain areas.

Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Land and Water Management Division, Michigan Department of Natural Resources, for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Land and Water Management Division, Michigan Department of Natural Resources, before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this control is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which will cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Michigan Department of Natural Resources urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, U.S. Department of Agriculture, carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". The Soil Conservation Service and Michigan Department of Natural Resources have agreed to carry out flood plain management studies in Michigan under provisions of the Joint Coordination Agreement. Priorities regarding location and extent of such studies in Michigan have been set in cooperation with the Michigan Department of Natural Resources.

The Branch County Soil Conservation District, city of Coldwater, Coldwater Township, Girard Township, Branch County Road Commission and Michigan Department of Natural Resources (Sponsors) believed that a flood plain management study was needed for Cold Creek, County Drain No. 15 and the Lower Lake Chain, consisting of Morrison Lake, Craig Lake and Coldwater River above Hodunk Dam, due to expected increased urbanization in the watershed and the flooding problems that are already occurring. The Sponsors have determined that there is an increasing need to properly plan for the preservation and use of the flood plain in their urban and rural areas. They have indicated a need to develop technical information along Cold Creek to develop effective management programs.

The Sponsors have adopted resolutions indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their communities.

A request for a flood plain management study was made by the Sponsors and a plan of work, dated November 1989, was agreed to by the Sponsors, along with the Soil Conservation Service. Financial contributions for this study were made by the Sponsors and the Soil Conservation Service. The Branch County Soil Conservation District will assist the other Sponsors with public information dissemination.

The Sponsors provided money for aerial photography for flood plain delineation uses and for watershed modeling purposes. They also furnished assistance to the Soil Conservation Service in gathering basic data. In addition, they also provided input to identify and select appropriate flood plain management alternatives.

The Land and Water Management Division, Michigan Department of Natural Resources, provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes and provisions of the Federal Flood Insurance Program.

Natural flood plain values were obtained by Soil Conservation Service field staff. Aerial photographs and field checks were used to identify and delineate wetland areas. Topographic maps, planning commission data and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published Soil Survey Report for Branch County.

Historic and archaeological data were obtained from township and county historians. Fishery management information was obtained from Michigan Department of Natural Resources field staff.

Two floods were delineated as part of this study, the 100-year and the 500-year frequency events. These delineations are shown on the flood hazard area photomaps in Appendix A. These floods have an average occurrence of once in the number of years as indicated; e.g. the 100-year flood occurs once in 100 years on the average. The 100-year flood has a one percent chance of being equaled or exceeded in any given year. In addition to the two floods delineated on the aerial photomaps, the 10-year and 50-year floods are also shown on the high water profiles. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Land and Water Management Division, Michigan Department of Natural Resources, and the Soil Conservation Service, U.S. Department of Agriculture, will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance contact:

Branch County Soil Conservation District
1110 West Chicago Road
Coldwater, Michigan 49036-7307
Telephone: (517) 278-8008

DESCRIPTION OF STUDY AREA

Watershed Area

Cold Creek is a tributary of Coldwater River located in the south-central part of lower Michigan in the eastern half of Branch County. It is located in U.S. Geological Survey's State Hydrologic Unit 04050001. Coldwater River's headwaters are located in the southeastern corner of Branch County. From there, Coldwater River flows in a northerly direction into the Upper Lake Chain which includes, from south to north, Coldwater, East, Long, Wright, Bartholomew, Archer, Middle, Marble and First Lakes. The level of the Upper Lake Chain has a common level and is controlled by dams on Sauk River (outlet of Marble Lake) and Coldwater River (outlet of Coldwater Lake). The Sauk and Coldwater Rivers flow in a northerly direction and outlet into the Lower Lake Chain which includes, from south to north, South, Randall, Morrison and Craig Lakes and Hodunk Pond. From there, Coldwater River flows north into St. Joseph River.

The drainage area to Hodunk Pond is approximately 173 square miles with land uses of commercial, residential, recreation, agriculture, forest and open space. About 19 percent of the area is in woodland and about 67 percent is in cultivated crops. The remaining 14 percent is roads, urban and small water areas. There are numerous culverts and crossings along the river system. Some of these are restrictive and cause the flooding of buildings and roads. Any replacement of crossings should be evaluated to determine the effect on water surface profiles.

There are six soil associations in the drainage area. About forty-five percent of the area is Locke-Barry-Hillsdale association, which has level to moderately sloping, somewhat poorly drained, poorly drained and well drained loamy soils on till plains and moraines. Twenty percent of the area consists of Fox-Oshtemo-Ormas association, which has nearly level to moderately steep, well drained loamy and sandy soils on outwash plains and moraines. Fifteen percent is Matherton-Sebewa-Branch association, which has level to gently sloping, moderately well drained to poorly drained loamy and sandy soils on outwash plains and moraines. Twelve percent of the area is Fox-Houghton-Edwards association, which has nearly level to moderately sloping, well drained loamy soils on outwash plains and moraines and level, very poorly drained mucky soils in swamps, depressions and drainageways. Six percent is Hatmaker-Locke-Barry association, which is level to undulating, somewhat poorly drained loamy soils on till plains and moraines. Two percent of the area is Morley-Locke-Houghton association, which has nearly level to gently rolling, well drained and somewhat poorly drained silty and loamy soils on till plains and moraines and level, very poorly drained mucky soils in swamps and depressions.

The 1986 Soil Survey Report for Branch County can be used to identify use and management of soils, including crops and pasture, woodland management and productivity, windbreaks and environmental plantings, recreation, wildlife and engineering. In addition, the soil survey can be used to determine soil properties, including engineering index properties, physical and chemical properties, and soil and water features.

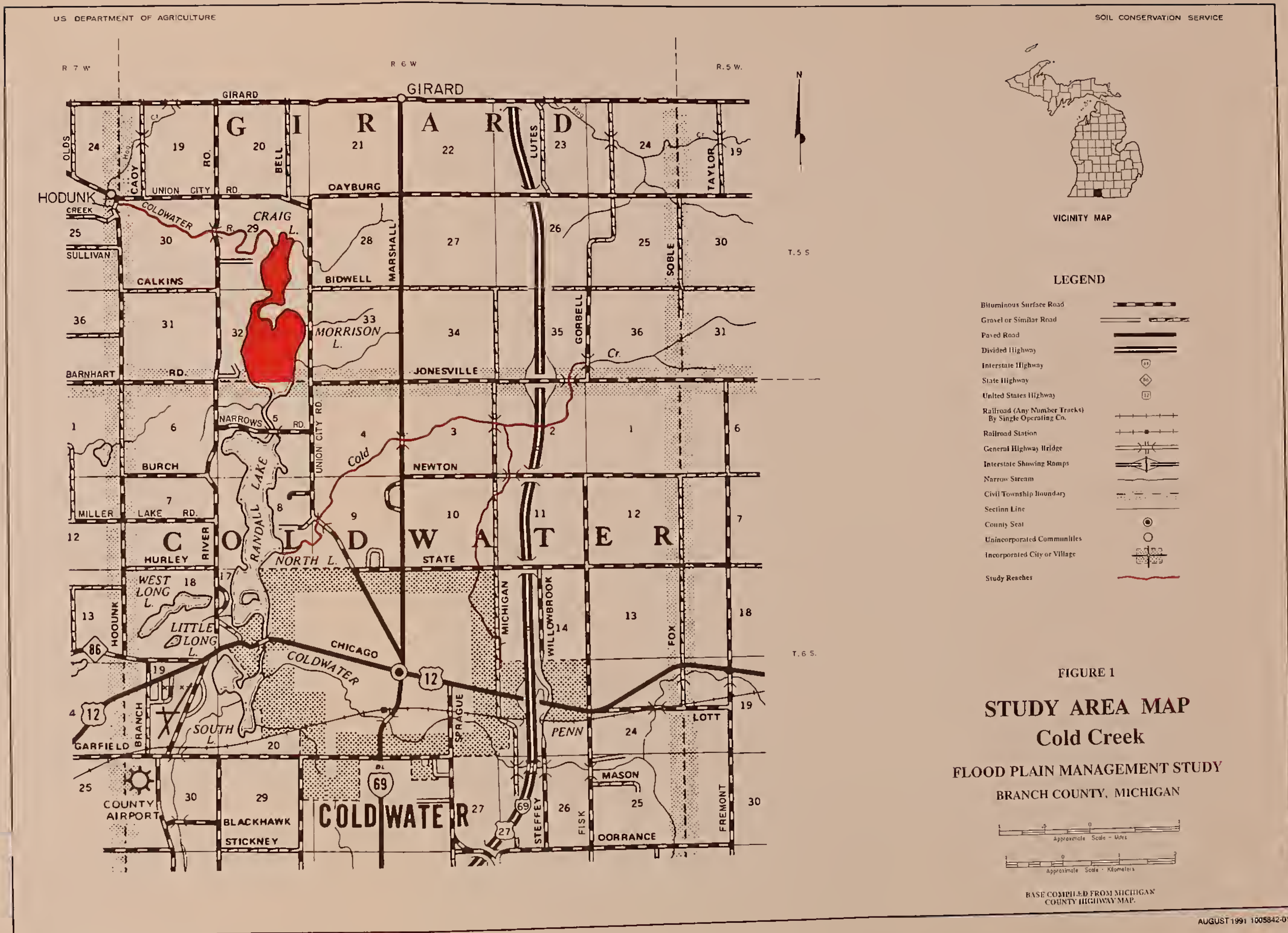
In winter, the average temperature is 25°F, and the average daily minimum temperature is 17°F. In summer, the average temperature is 69.1°F, and the average daily maximum temperature is 80.7°F.

The average annual temperature is 47.8°F. The average annual precipitation is 33.49 inches. Of this, 20.68 inches, or 62 percent, usually falls in April through September, which includes the growing season for most crops. The average annual snowfall is 47.8 inches.

Historically, much of the watershed has been used for agriculture. Since the 1930's, farming has shifted somewhat from livestock to cash crops, mainly corn, soybeans and wheat. About seven percent of the area is used for hay and pasture.

Study Area Flood Plain

The study area is contained within Coldwater and Girard Townships. High water profiles and flood plain delineations were made along Cold Creek and County Drain No. 15 for a distance of 8.7 miles. In addition, flood plain delineations were made along the Lower Lake Chain, which includes Morrison Lake, Craig Lake and Coldwater River above Hodunk Dam in Girard Township. The study area is identified in Figure 1.



USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX-1992

NATURAL VALUES

The study area flood plain has a number of natural and beneficial values. It serves as a storage area for spring rains and snow melts. It acts as a filter for minimizing the amount of pollutants reaching the lakes, creeks and open drains, thereby maintaining water quality. It supports a wide variety of plant, animal and tree species.

"These species are found in suitable habitat in the river flood plain itself or in the environments adjacent to the actual flood plain. Some of these species are abundant, some common and some are little known by human inhabitants living in this drainage system." 1/

Representative mammals found in the flood plain area are the white-tailed deer, striped skunk, mink, least weasel, long-tailed weasel, raccoon, gray and red fox, coyote (population low), meadow jumping mouse, house mouse, Norway rat, southern bog lemming, muskrat, woodland vole, white-footed mouse, beaver, southern flying squirrel, red squirrel, fox squirrel, limited number of gray squirrels (mostly black phase), thirteen-lined ground squirrel, woodchuck, eastern chipmunk, eastern cottontail rabbit, red bat, big brown bat, silver-haired bat, Indiana bat (status not known in Branch County), little brown bat, Keen's bat, star-nosed mole, eastern mole, least shrew, short-tailed shrew and masked shrew. Virginia oppossum and badgers are sometimes observed in the upland sites.

Various species of upland game birds, non-game birds and raptors are found in the flood plain. These include screech owl, horned owl, night hawk, red tailed hawk, sharp-shinned hawk, coopers hawk, bob white, quail, ring-necked pheasant, sora rail, killdeer, woodcock, mourning dove, chimney swift, ruby throated hummingbird, flicker, belted kingfisher, redheaded woodpecker, hairy and downy woodpeckers, eastern kingbird, horned lark, tree swallow, barn swallow, purple martin, blue jay, robin, crow, black capped chicadee, tufted titmouse, white breasted nuthatch, brown creeper, house wren, catbird, brown thrasher, bluebird, cedar waxwing, starling and English sparrow. Several species of warblers migrate through the area and the yellow-throated warbler nests there.

Common waterfowl that may be found during migration are the mute swan, Canada goose, mallard duck, black duck, baldpate, pintail, green-winged teal, shoveller, wood duck, redhead duck, ring-neck duck, canvas-back duck, lesser scaup, American golden eye, bufflehead, hooded merganser and red-breasted merganser. Great blue herons, little blue herons, green herons and American bitterns can also be found.

"There are no known endangered or threatened species in the area. However, there are historical records of two fish species that are listed as special concern species. They are the spotted gar (Lepisosteus oculatus) and the starhead topminnow (Fudulaus notti)." 2/

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1/ Ralph Anderson, Wildlife Habitat Biologist, Michigan Department of Natural Resources.

2/ Thomas Weise, Endangered Species Coordinator, Michigan Department of Natural Resources.

The tree species in the river bottoms are primarily hardwoods. "Southern Michigan is where northern species and southern species come together so there is a great variety of species present." 1/

The genus with the most representatives is the white oak group, consisting of White Oak, Burr Oak, Swamp White Oak and Chinkapin Oak. In the red oak group are the Northern Red Oak, Black Oak, Pin Oak and Shingle Oak.

There are several willow species: Cottonwood, Quaking Aspen, Bigtooth Aspen, Black Walnut and Butternut. There are four different hickories: shagbark, pignut, bitternut and shellbark. There are hophornbeam, hornbeam and American beech.

The native elm trees have been severely impacted by Dutch Elm Disease. Hackberry and Mulberries are found, as are Yellow Poplar, Whitewood and Sassafras. Sycamore, Black Cherry, Pin Cherry and Chokecherry are also found. Sugar Maple, Black Maple, Red Maple, Silver Maple and Box Elder represent the maple family. Also found within the flood plain are Basswood, Dogwood, White Ash, Black Ash, Green Ash, Tamarack and Red Cedar.

Water Quality

"The lake chains provide a haven for swimming, boating, fishing, skiing and other recreational opportunities for both property owners and the general public. Historical and recent baseline limnological surveys for the eastern chain of lakes of the flood plain area indicate the lakes in the chain, with the exception of Coldwater Lake, to be eutrophic. Coldwater Lake, the deepest and largest lake in the chain, is mesotrophic." 2/

Sediment loading to the waters in the lake chain has significantly impaired fishery habitat and recreational utilization of the lakes. It is thought that fish populations have been severely impacted by sediment settling in spawning strata. Also, excessive algae growth in all the lakes in the flood plain study area has impaired recreational usage.

High water levels in the spring and the water quality concern prompted the establishment in 1986 of the Marble-Coldwater Lake Board. Pursuant to this board's request, an engineering study was completed in November 1986 which outlined remedial actions to stabilize lake levels and improve the water quality in the Marble-Coldwater Lake Chain.

In October 1987, the Messenger-Hodunk Lake Association entered into an agreement with Branch County Soil Conservation District to evaluate non-point source pollution entering the chain of lakes.

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1/ William Hoppe, Area Forester, Michigan Department of Natural Resources.
2/ Marble-Coldwater Lake Chain Feasibility Study - Progressive Architects/Engineers/Planners, Inc., Published November 1986.

FLOOD PROBLEMS

Annual flooding occurs in the early spring due to a combination of snowmelt and rainfall, and occasionally in the fall due to heavy rains.

Cold Creek:

Flood damages along Cold Creek are primarily limited to Old 27 (Marshall Street), Gorbell Road and cropland along the channel. The 100-year flood inundates approximately 529 acres. Most of the inundated area is stream and wetland. The 100-year water surface elevation is approximately 0.8 feet higher than the low point in the road at the Old 27 crossing. The road is impassable and traffic must be rerouted. Also, the 100-year water surface elevation is approximately 3.1 feet higher than the low point in the road at the Gorbell Road crossing. The road is impassable and traffic must be rerouted.

County Drain No. 15:

With the exception of a private crossing at station 112+31 (CS 24.0) and a few wetland areas, County Drain No. 15 has capacity for a 100-year flood. The 100-year flood inundates only 77 acres.

Lower Lake Chain (Morrison Lake, Craig Lake and Coldwater River above Hodunk Drain, located in Girard Township):

A considerable amount of flooding occurs in areas around the Lower Lake Chain in Girard Township. The 100-year flood inundates approximately 226 acres above the normal lake level of 924.0 feet. Most of this inundated area is wetland; however, about 28 homes and/or cottages would experience first floor flooding.

This study provides, in Appendix A, high water profiles and flood hazard area photomaps that show the areas subject to flooding based on analyses of existing stream hydraulics and current watershed and flood plain conditions. Water surface profiles along the study reaches are shown for the 10-year, 50-year, 100-year and 500-year flood events. The approximate areas of inundation for two floods, the 100-year and 500-year, are shown on the aerial photomaps.

There are areas in Coldwater and Girard Townships that are flood-prone and are not shown in this report. These flood-prone areas are a result of soil and high water table conditions. The Soil Survey of Branch County, issued in September 1986, describes and delineates these areas. Elevations for the Lower Lake Chain are from the May 1988 Coldwater River Flood Plain Management Study.

Typical valley sections, shown in Appendix B, indicate the effects of the four floods. Flood discharges used for computing high water profiles in the study area are shown in Table 1, in Appendix C. Table 2, in Appendix C, shows flood elevations at each of the surveyed valley sections for present conditions.

Floodways have been delineated for Cold Creek and have been provided to the Sponsors in a separate report.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can often totally block an opening. To determine possible effects, look at the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as cross-sectional area available for flow.

DETERMINATION OF FLOOD HAZARD FOR SPECIFIC LOCATION

To determine flood levels for a specific location, locate the area on the sheet index, Figure 2 (Appendix A), identifying the appropriate flood hazard photomap. Using this photomap, locate the specific location on the map and its relationship to the nearest identification point (cross-section, road).

If the specific location is outside the flood hazard boundaries, there is no apparent flood hazard. *

For those areas within the flood hazard boundaries, refer to the adjacent high water profile, locating the area on the profile. The mean sea level flood elevation can then be determined for the appropriate flood event. Table 2 (Appendix C) shows flood elevations at each cross-section.

* Note: Areas outside the flood hazard boundaries may be subject to high water table soils (see 1986 Branch County Soil Survey) or local flooding conditions which are beyond the scope of this study.

EXISTING FLOOD PLAIN MANAGEMENT

Currently, Coldwater Township and the city of Coldwater are utilizing information provided in the May 1988 Coldwater River Flood Plain Management Study prepared by the Soil Conservation Service, U.S. Department of Agriculture, to enforce the Basic Building Code (BOCA). The BOCA code requires that the lowest horizontal structural member of buildings be at or above the 100-year flood elevation.

Girard Township has no existing flood plain ordinances or flood insurance. This Flood Plain Management Study provides the technical information needed to enforce the existing building code (BOCA) in Garard Township.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objectives of flood plain management are to reduce the damaging effects of floods, preserve and enhance natural values and provide for optimal use of land and water resources within the flood plain. Flood plain management can minimize potential flood damages by:

1. Prohibiting uses which are dangerous to public health or safety in times of flood.

2. Restricting building or other development which may cause increased flood heights or velocities.

3. Requiring that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.

4. Protecting individuals from investments in flood hazard areas which are unsuited for their intended purposes.

5. Providing information on flood proofing techniques for existing structures in the flood plain.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages. Many of the road crossings should be resized when replacement is necessary.

Present Condition

This is the "no change" alternative, which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

Land Treatment

This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce runoff. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is a growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas reduce either the volume or the rate of runoff. The effectiveness of any control method depends on the available storage, the outflow rate and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measure for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Groundwater recharge a. Perforated pipe b. Gravel (sand) trench c. Dry wells 5. Vegetated depressions	1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters or diversions

Preservation and Restoration of Natural Values

Flood plains, in their natural or relatively undisturbed state, provide three broad sets of natural and beneficial resources and resource values.

Water resource values include natural moderation of floods, water quality maintenance and groundwater recharge. The physical characteristics of the flood plain shape flood flows. Flood plains generally provide a broad area to spread out and temporarily store flood waters. This reduces flood peaks and velocities and the potential for erosion.

Flood plains serve important functions in protecting the physical, biological and chemical integrity of water. A vegetated flood plain slows the surface runoff, causing it to drop most of its sediment load on the flood plain. Pathogens and toxic substances entering the main water body through surface runoff and accompanying sediments are decreased.

The natural flood plain often has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff provides additional time for it to infiltrate and recharge available ground water aquifiers, and often provides for natural purification of the waters.

Flood plains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly and indirectly by flood plains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment and physical well-being.

The flood plain is biologically important because it is the place where land and water meet and the elements of both terrestrial and aquatic ecosystems mix. Shading of the stream by flood plain vegetation moderates water temperatures; roots and fallen trees provide instream habitat; and near stream vegetation filters runoff, removing harmful sediments and buffering pollutants, to further enhance instream environments.

Flood plains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities were located along the coasts and rivers in order to have access to water supply, waste disposal and water transportation. Consequently, flood plains include most of the nation's earliest archeological and historical sites. In addition to their historical richness, flood plains may contain invaluable resources for scientific research. For example, where flood plains contain unique ecological habitats, they make excellent areas for scientific study. Flood plains may provide open space community resources. In urban communities, they may provide green belt areas to break urban development monotony, absorb noise, clean the air and lower temperatures. Flood plain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

It is recommended that several selected open space areas be preserved, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damages and enhance the urban environment.

1. Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are very severe. The Soil Conservation Service has completed a detailed soil survey of Branch County. Copies of the material, including maps and interpretations, are available for reference in the Branch County Soil Conservation District Office located at 1110 West Chicago Road, Coldwater, Michigan 49036-9307. This information can be used to determine the kinds of soils in a given area and their limitations for various uses.

2. Upland open space should be retained in the natural state as much as possible.

3. Private wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.

4. Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peaks created by their urbanization.

5. Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have potential for an excellent outdoor classroom. The Cold Creek system is easily accessible to many high school and college students.

<u>Non-Structural Measures</u>

1. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations (Appendix A). Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.

2. Flood proof buildings and residences already in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain. If any buildings are subject to more than 3 feet of flood water, consideration should be given to relocation or elevation as viable methods to reduce flood damage.

3. Plans should be developed for alternate routes for automobile, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

4. Maintenance of Cold Creek and County Drain No. 15 appears to be good. Debris, fallen trees and brush should be removed at least yearly. Snow and ice from road clearing operations should not be piled in the flood plain. The dam should be opened as early in the fall as possible to provide storage for spring runoff.

5. Owners and occupants of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. The Sponsors should make necessary applications and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909 for additional information.

Structural Measures

Flood stages can be reduced by improving flow conditions within the channel by increasing the stream's carrying capacity. Methods recommended are improved bridge openings with reduced channel obstructions.

The following structural measures were considered as requested by the Sponsors: (Estimated costs have been provided to the Sponsors in a separate report.)

Cold Creek:

A private crossing at the gravel pit (CS 11.8), located at station 112+85, is causing the 100-year floodwaters to back up and flood Old 27 (Marshall Street). The road is impassable and traffic must be rerouted. Removal of CS 11.8 alone would not alleviate flooding of Old 27 (CS 12.0). In addition, channel construction would be required from station 100+00 to station 142+00.

The 100-year water surface elevation is approximately 3.1 feet higher than the low point in Gorbell Road. This is a hazardous situation. The road is impassable and traffic must be rerouted. Reconstruction of 600 feet of road and the addition of twin 8-foot by 12-foot concrete box culverts would prevent overtopping of Gorbell Road by the 100-year flood. In the event the crossing is not reconstructed, flash flood warning signs are highly recommended.

County Drain No. 15:

With the exception of a private crossing at station 112+31 (CS 24.0) and a few wetland areas, County Drain No. 15 has capacity for a 100-year flood. However, additional development as zoned in County Drain No. 15 Watershed (northeast of the city of Coldwater), will increase runoff and peak discharges. As a result of this increased peak discharge, the 100-year flood would overtop many of the roads, making them impassable. Traffic would have to be rerouted and maintenance costs would increase. Consequently, on-site detention and/or retention of the 100-year flood for all future development is recommended. In addition, maintenance (removal of brush and mowing or spraying) is recommended.

Lower Lake Chain:

An engineering firm has been retained by the Branch County Drain Commissioner to investigate repair and/or replacement of Hodunk Dam. Enlargement of the principal spillway may reduce flood elevations. The bridge 200 feet above Hodunk Dam has a significant effect on water surface elevations above the dam and must be considered in any hydraulic analysis of the dam.

APPENDIX A

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LEGEND

Bituminous Surface Road
Gravel or Similar Road
Paved Road
Divided Highway
Interstate Highway
State Highway
United States Highway
Railroad (Any Number Tracks) By Single Operating Co.
Railroad Station
General Highway Bridge
Interstate Showing Ramps
Narrow Stream
Civil Township Boundary
Section Line
County Seat
Unincorporated Communities
Incorporated City or Village
Sheet Coverage

FIGURE 2

PHOTO SHEET INDEX MAP

Cold Creek

FLOOD PLAIN MANAGEMENT STUDY

BRANCH COUNTY, MICHIGAN

Approximate Scale - Miles

Approximate Scale - Kilometers

BASE COMPILED FROM MICHIGAN COUNTY HIGHWAY MAP.

AUGUST 1991 1005842-02

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX-1992

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 16.1 Valley Section Location
- Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 — 800 — 1600 FEET
0 — 200 — 400 METERS
APPROXIMATE

1989 Photography From Abrams Aerial Survey Corp.

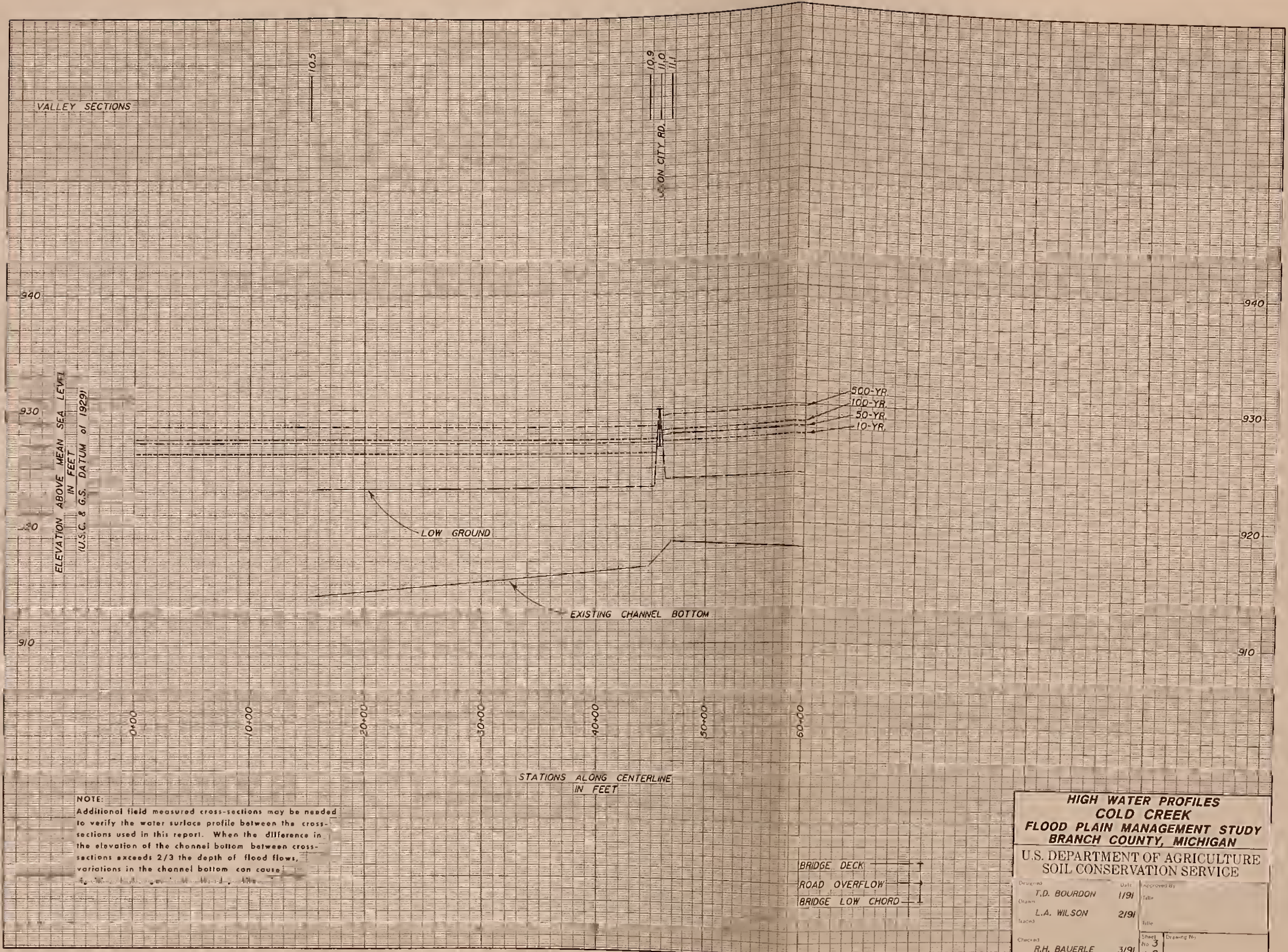
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLD CREEK

SHEET 1 OF 8

AUGUST 1991 1005842


VALLEY SECTIONS
10.5
10.9
11.0
11.1
UNION CITY RD.
940
930
920
910
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
500-YR.
100-YR.
50-YR.
10-YR.
LOW GROUND
EXISTING CHANNEL BOTTOM
0+00
10+00
20+00
30+00
40+00
50+00
60+00
STATIONS ALONG CENTERLINE IN FEET
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause
BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
T.D. BOURDON 1/91
L.A. WILSON 2/91
R.H. BAUERLE 3/91
Sheet No. 3 of 8

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 16.1 Valley Section Location
- Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

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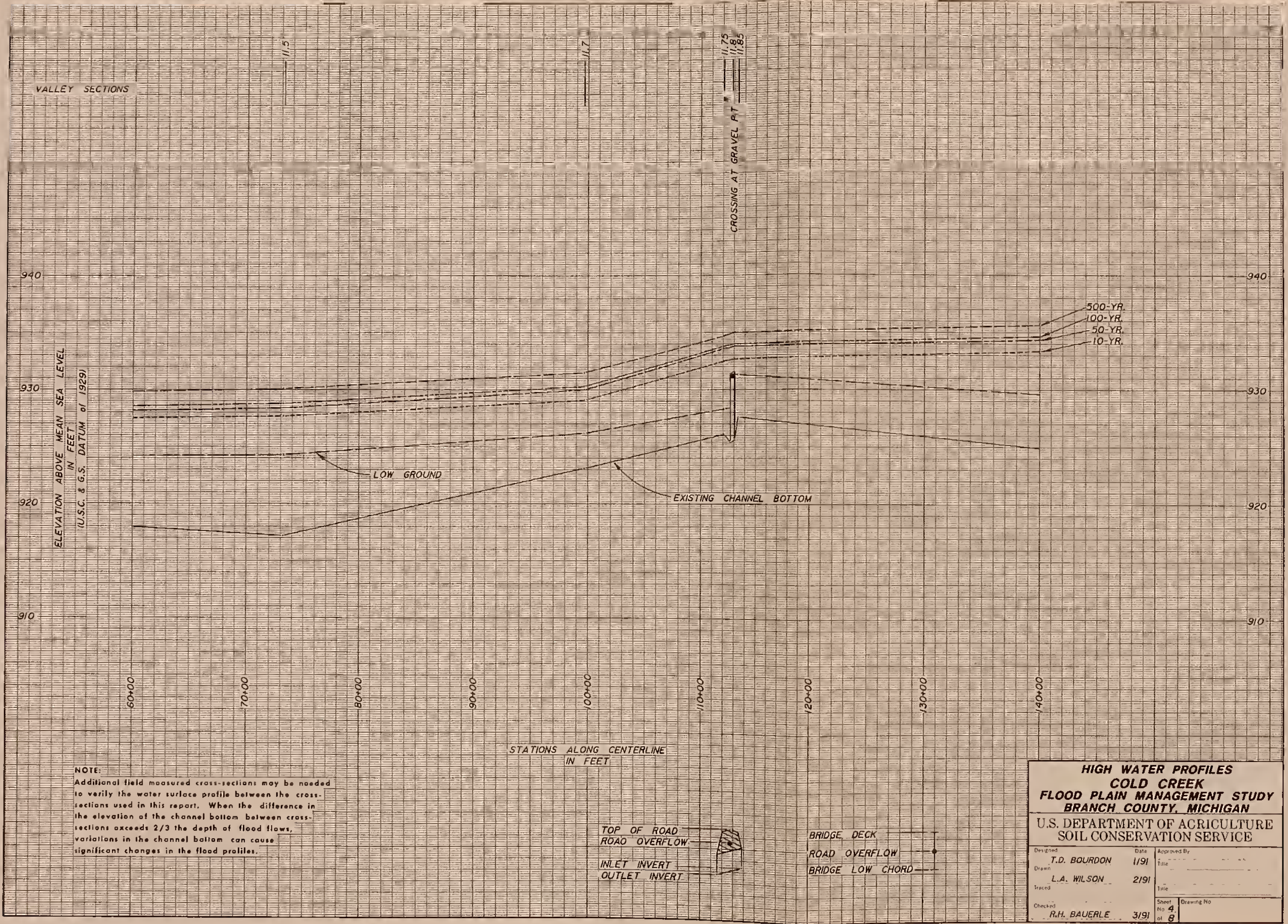
SOIL CONSERVATION SERVICE

COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLD CREEK

AUGUST 1991 1005842



NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

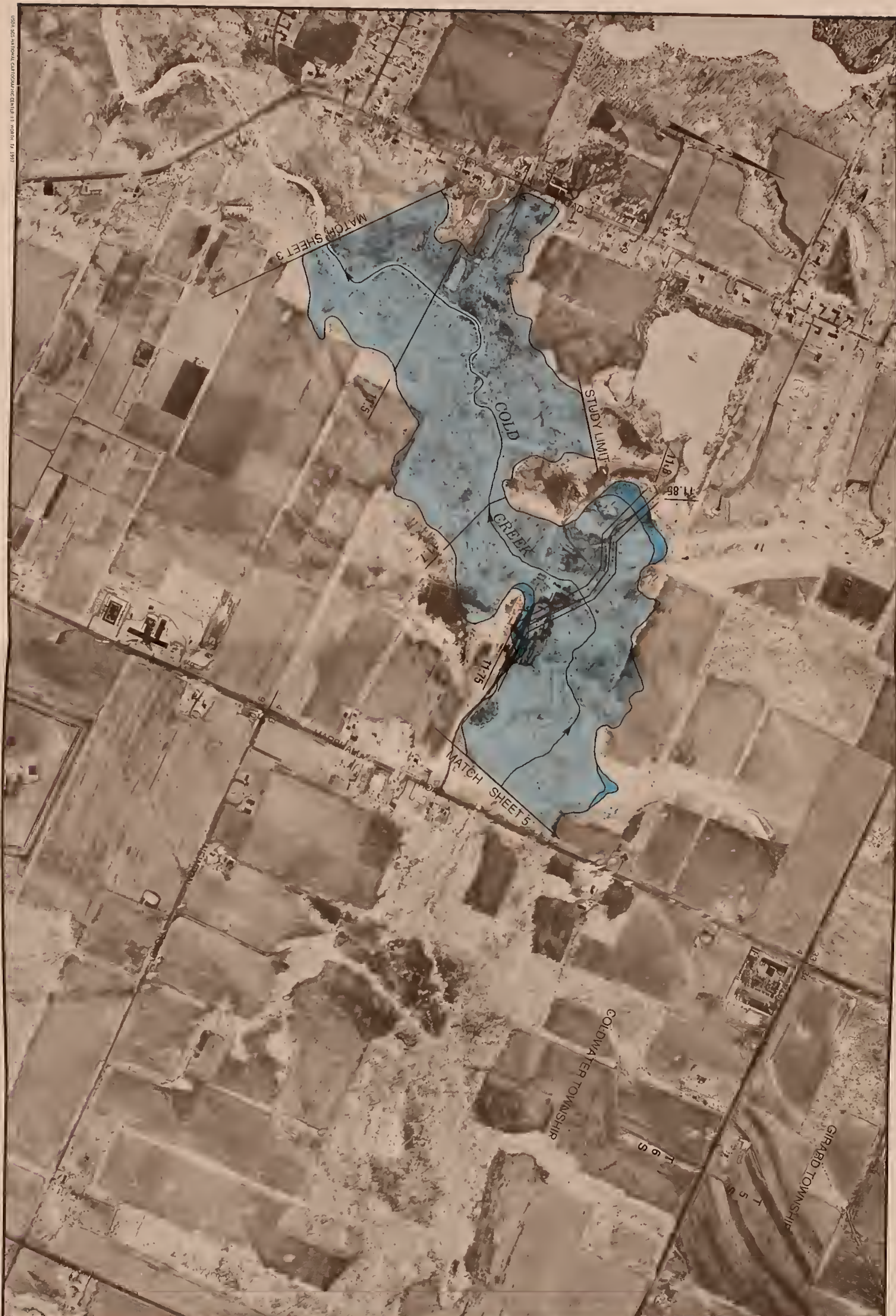
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T.D. BOURDON	Date 1/91
Drawn	L.A. WILSON	2/91
Traced		
Checked	R.H. BAUERLE	3/91

Approved By
Title
Title

Sheet No. 4 of 8
Drawing No



LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 16.1 Valley Section Location
- Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

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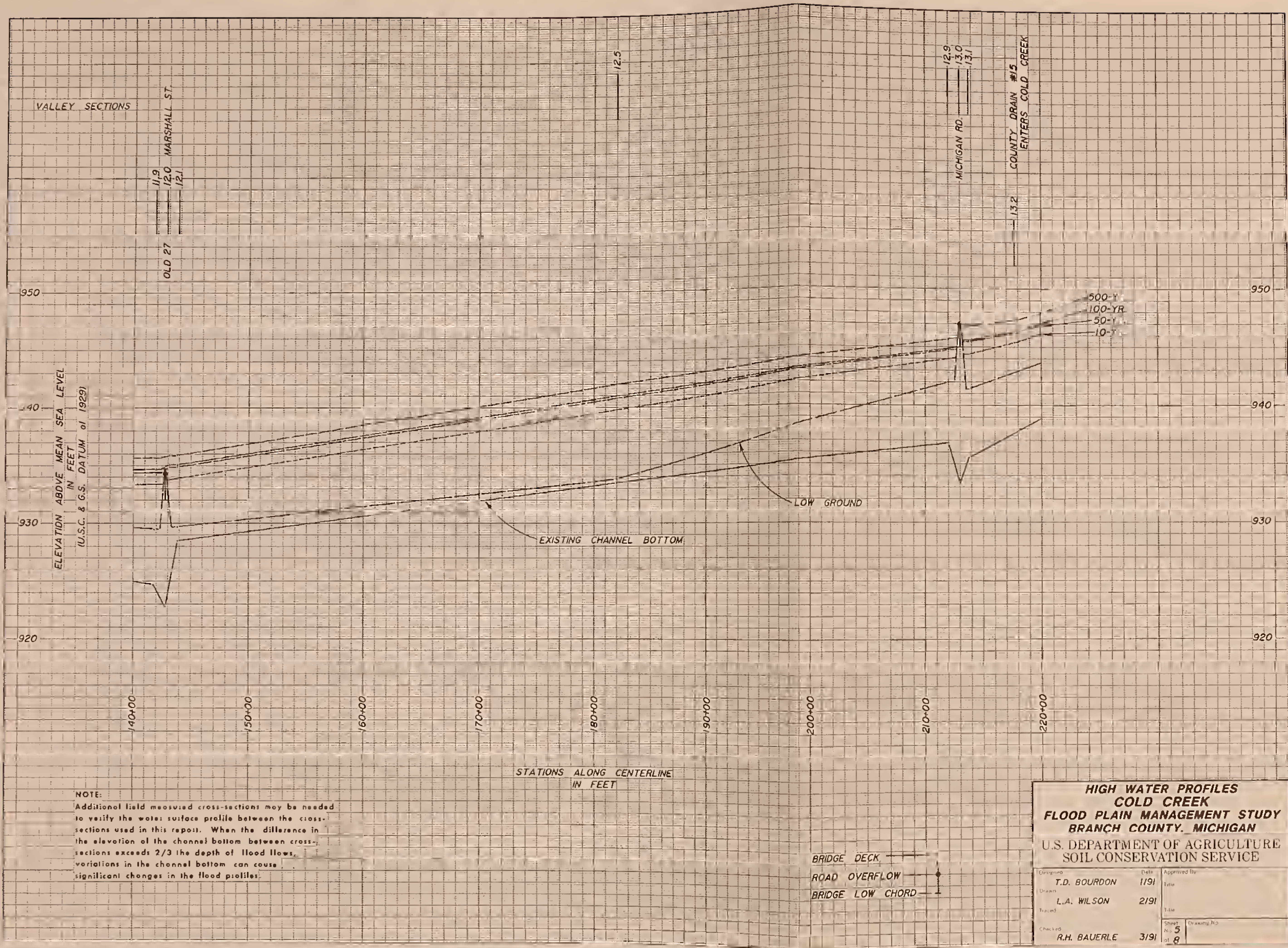
SHEET 4 OF 8

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLD CREEK



VALLEY SECTIONS
11.9
12.0
12.1
OLD 27
MARSHALL ST.
12.5
12.9
13.0
13.1
MICHIGAN RD.
13.2
COUNTY DRAIN #15 ENTERS COLD CREEK
500-YR
100-YR
50-YR
10-YR
LOW GROUND
EXISTING CHANNEL BOTTOM
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
950
940
930
920
140+00
150+00
160+00
170+00
180+00
190+00
200+00
210+00
220+00
STATIONS ALONG CENTERLINE IN FEET
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.
BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T.D. BOURDON Date 1/91
Drawn L.A. WILSON 2/91
Traced
Checked R.H. BAUERLE 3/91
Approved By
Title
Title
Sheet No. 5 of 8
Drawing No.

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 16.1 Valley Section Location
- Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 — 800 — 1600 FEET
0 — 200 — 400 METERS
APPROXIMATE

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

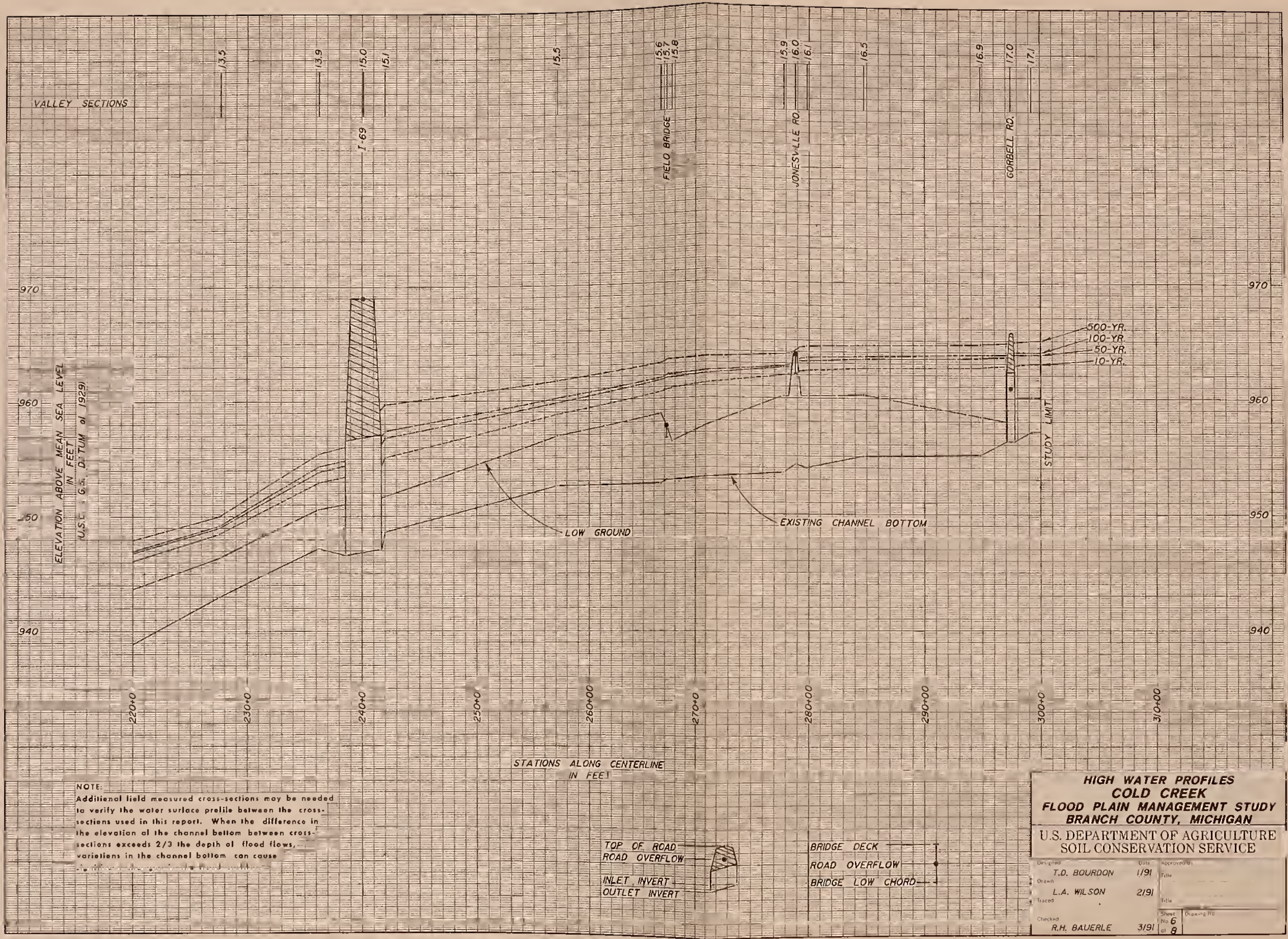
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLD CREEK

SHEET 5 OF 8

AUGUST 1991 1005842



VALLEY SECTIONS
13.5
13.9
15.0
15.1
15.5
15.6
15.7
15.8
15.9
16.0
16.1
16.5
16.9
17.0
17.1
I-69
FIELD BRIDGE
JONESVLLE RD.
GORBELL RD.
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
970
960
950
940
500-YR.
100-YR.
50-YR.
10-YR.
STUDY LIMIT
LOW GROUND
EXISTING CHANNEL BOTTOM
220+0
230+0
240+0
250+0
260+00
270+0
280+00
290+0
300+0
310+00
STATIONS ALONG CENTERLINE IN FEET
NOTE:
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TOP OF ROAD
ROAD OVERFLOW
INLET INVERT
OUTLET INVERT
BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T.D. BOURDON 1/91
Drawn L.A. WILSON 2/91
Checked R.H. BAUERLE 3/91
Sheet No. 6 of 8

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

16.1 Valley Section Location

Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT. THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

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SOIL CONSERVATION SERVICE

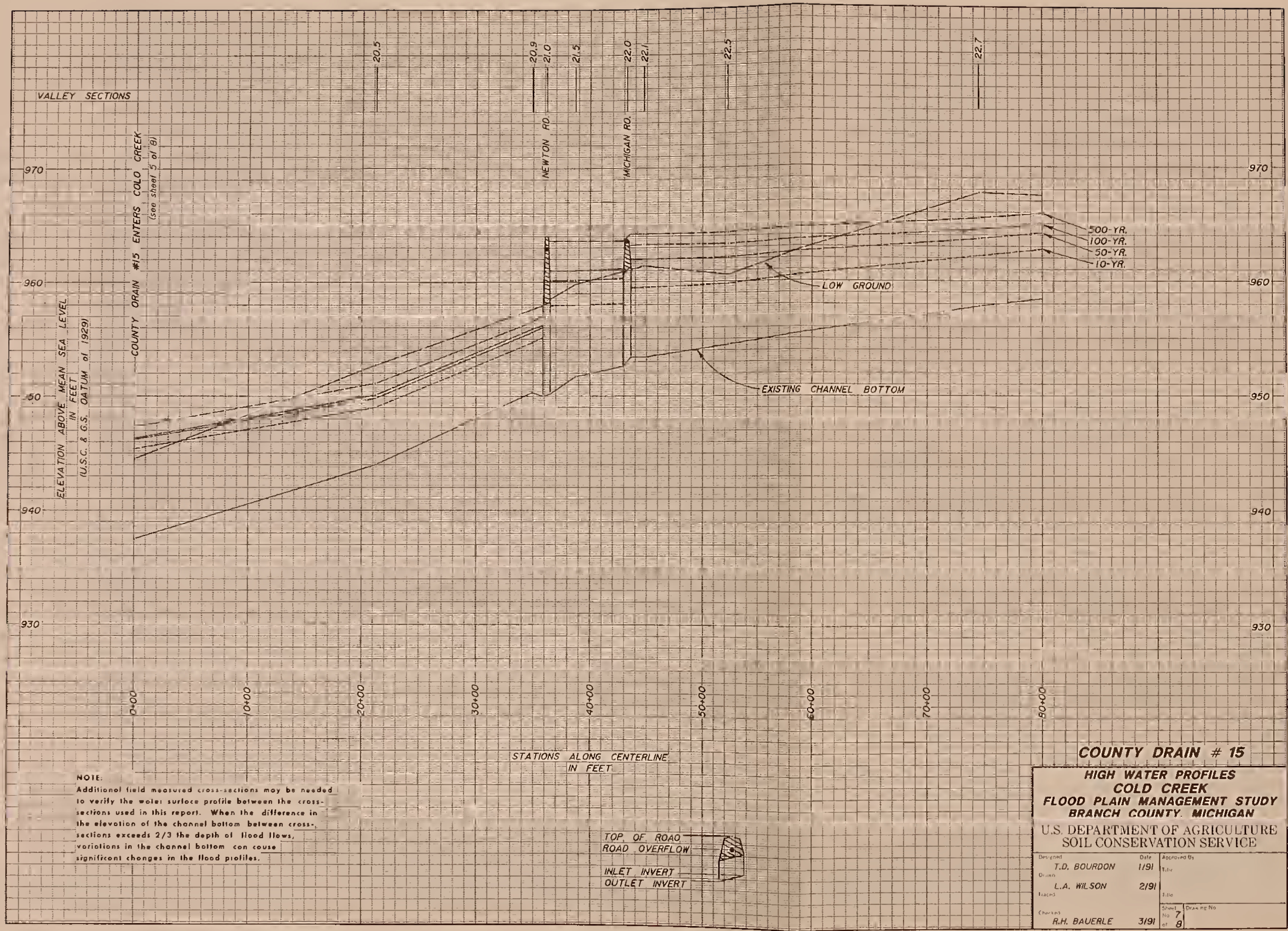
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

SHEET 6 OF 8

AUGUST 1991 1005842

FLOOD HAZARD AREA

COLD CREEK


VALLEY SECTIONS
20.5
20.9
21.0
21.5
22.0
22.1
22.5
22.7
NEWTON RD.
MICHIGAN RD.
COUNTY DRAIN #15 ENTERS COLD CREEK
(see sheet 5 of 8)
ELEVATION ABOVE MEAN SEA LEVEL IN FEET
(U.S.C. & G.S. DATUM of 1929)
970
960
950
940
930
500-YR.
100-YR.
50-YR.
10-YR.
LOW GROUND
EXISTING CHANNEL BOTTOM
0+00
10+00
20+00
30+00
40+00
50+00
60+00
70+00
80+00
STATIONS ALONG CENTERLINE IN FEET
NOTE:
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TOP OF ROAD
ROAD OVERFLOW
INLET INVERT
OUTLET INVERT
COUNTY DRAIN # 15
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T.D. BOURDON 1/91
Drawn L.A. WILSON 2/91
Checked R.H. BAUERLE 3/91
Sheet No. 7 of 8

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 16.1 Valley Section Location
- Stream Channel

NOTE:
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SCALE 0 — 800 — 1600 FEET
0 — 200 — 400 METERS
APPROXIMATE

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AUGUST 1991 1005842

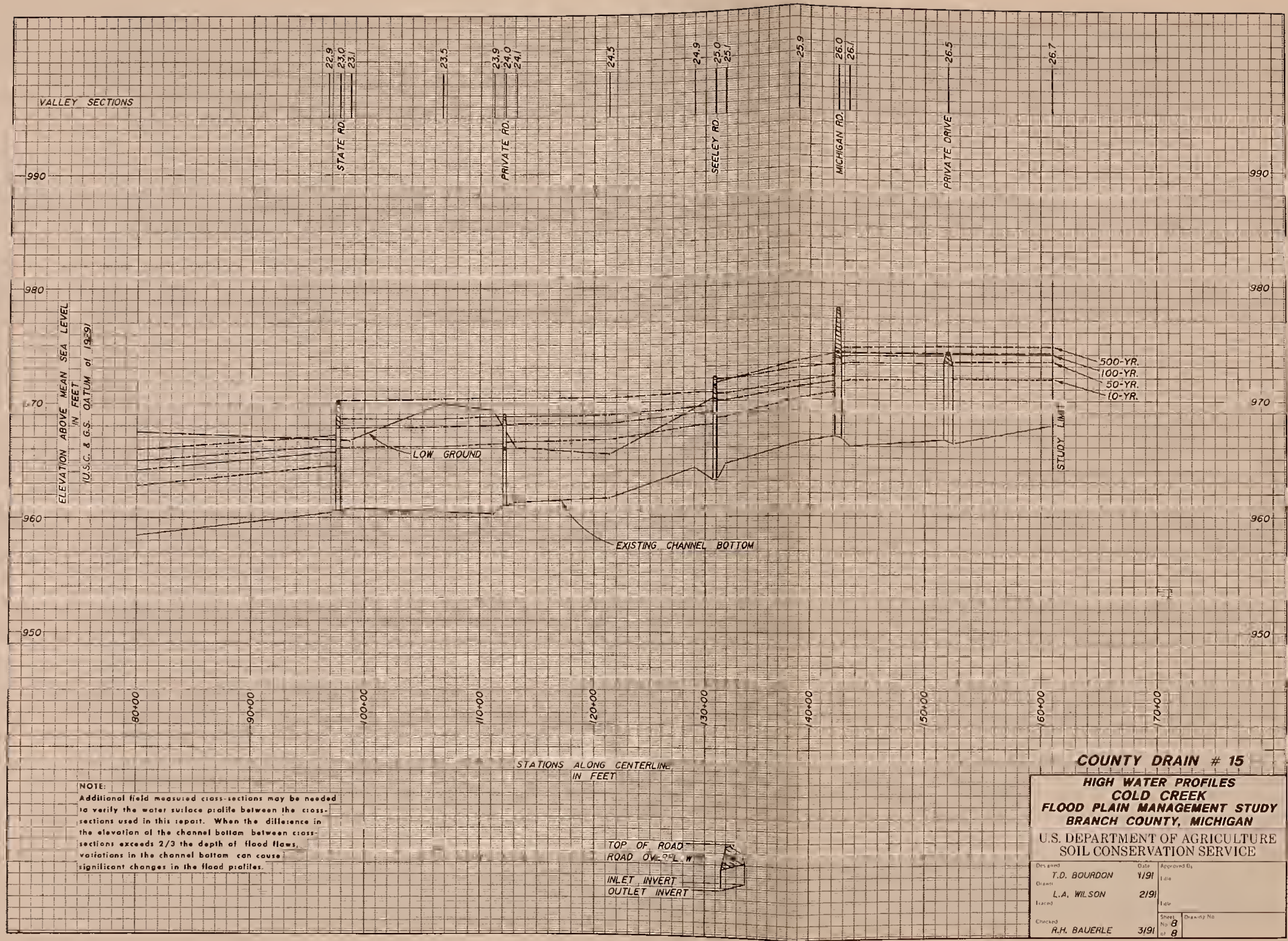
SHEET 7 OF 8

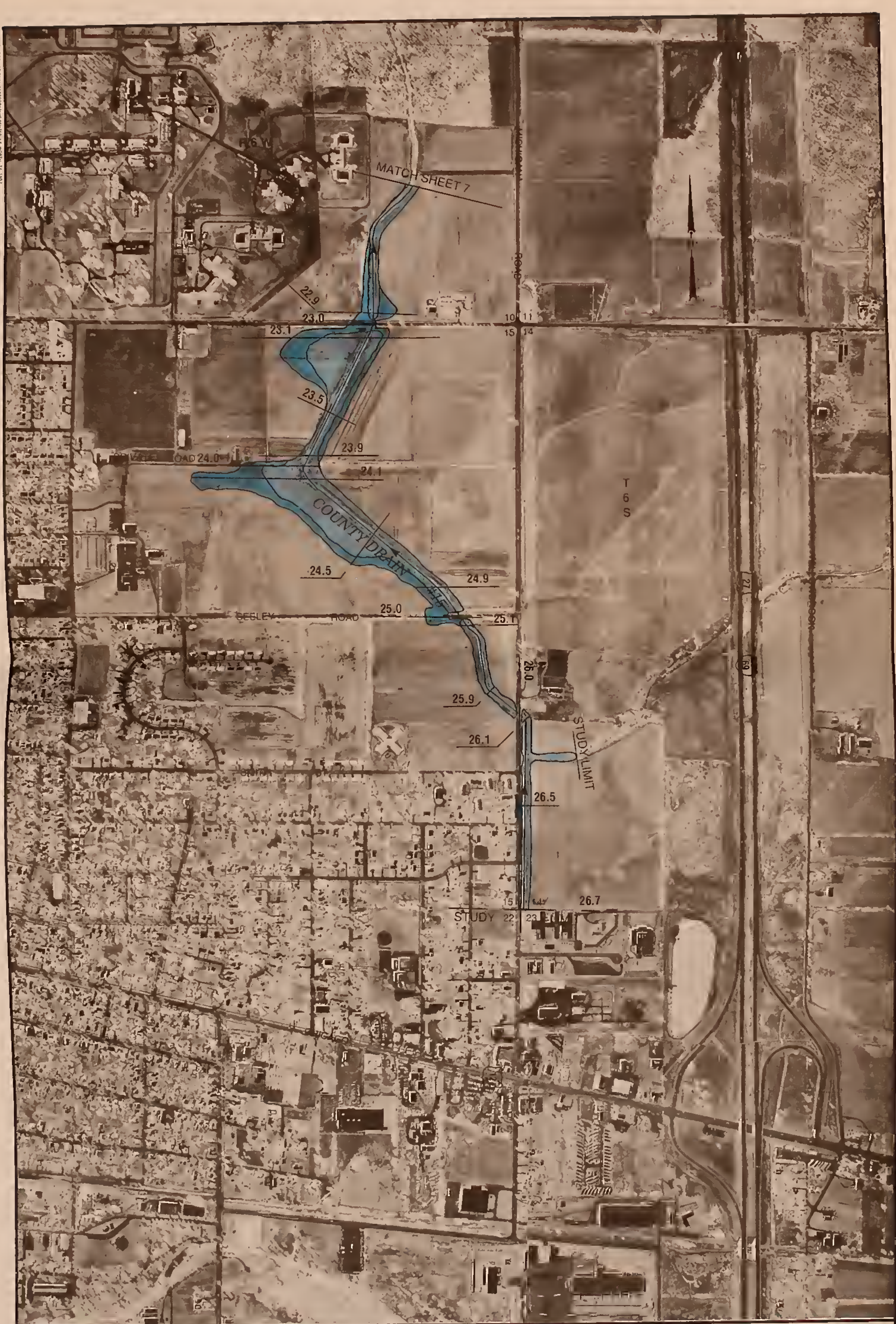
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COUNTY DRAIN #15


VALLEY SECTIONS
22.9
23.0
23.1
23.5
23.9
24.0
24.1
24.5
24.9
25.0
25.1
25.9
26.0
26.1
26.5
26.7
STATE RD.
PRIVATE RD.
SEELEY RD.
MICHIGAN RD.
PRIVATE DRIVE
990
980
970
960
950
ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
(U.S.C. & G.S. DATUM of 1929)
500-YR.
100-YR.
50-YR.
10-YR.
LOW GROUND
STUDY LIMIT
EXISTING CHANNEL BOTTOM
80+00
90+00
100+00
110+00
120+00
130+00
140+00
150+00
160+00
170+00
STATIONS ALONG CENTERLINE
IN FEET
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.
TOP OF ROAD
ROAD OV
INLET INVERT
OUTLET INVERT
COUNTY DRAIN # 15
HIGH WATER PROFILES
COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T.D. BOURDON 1/91
Drawn L.A. WILSON 2/91
Traced
Checked R.H. BAUERLE 3/91
Approved By
Sheet No 8 of 8
Drawing No



LEGEND

	100 Year Flood Hazard Area
	500 Year Flood Hazard Area
16.1	Valley Section Location
	Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 — 800 — 1600 FEET
0 — 200 — 400 METERS
APPROXIMATE

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SOIL CONSERVATION SERVICE

COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

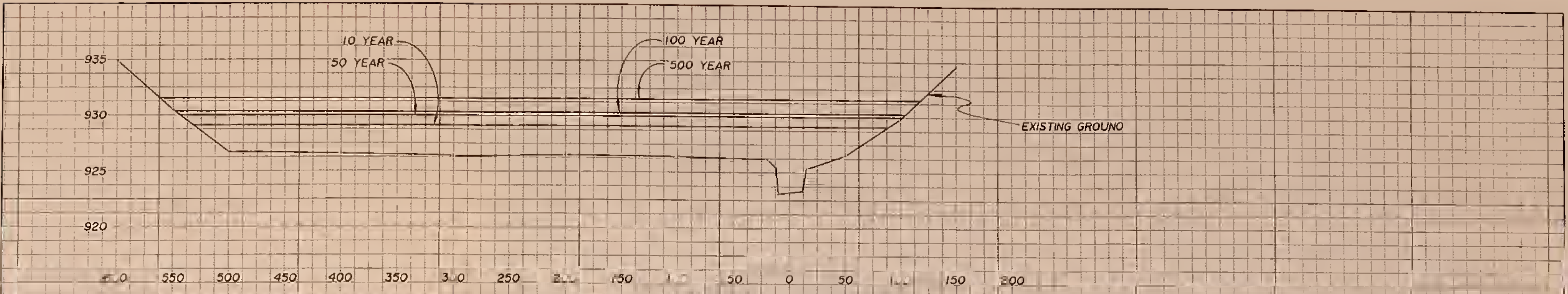
COUNTY DRAIN #15

SHEET 8 OF 8

AUGUST 1991 1005842

USDA SCS NATIONAL CARTOGRAPHIC CENTER FT WORTH TX 1991

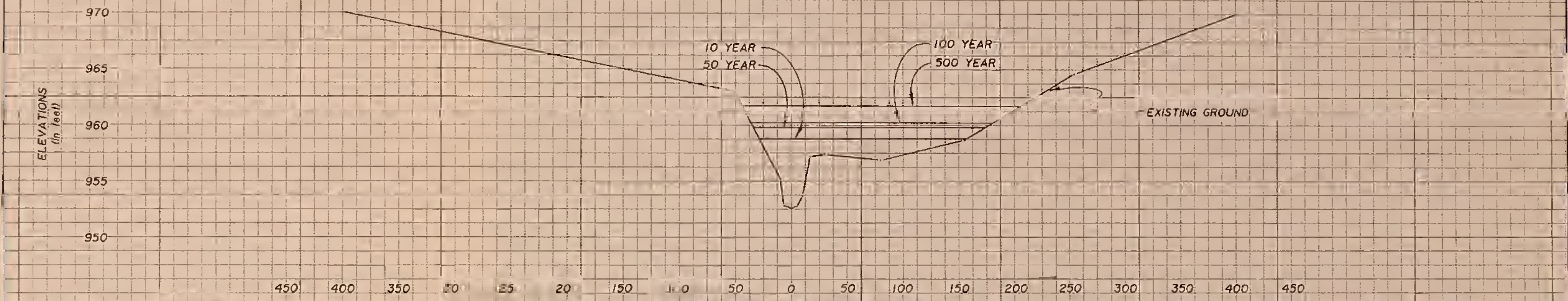
APPENDIX B



SECTION 11.7 -- STATION 99+66

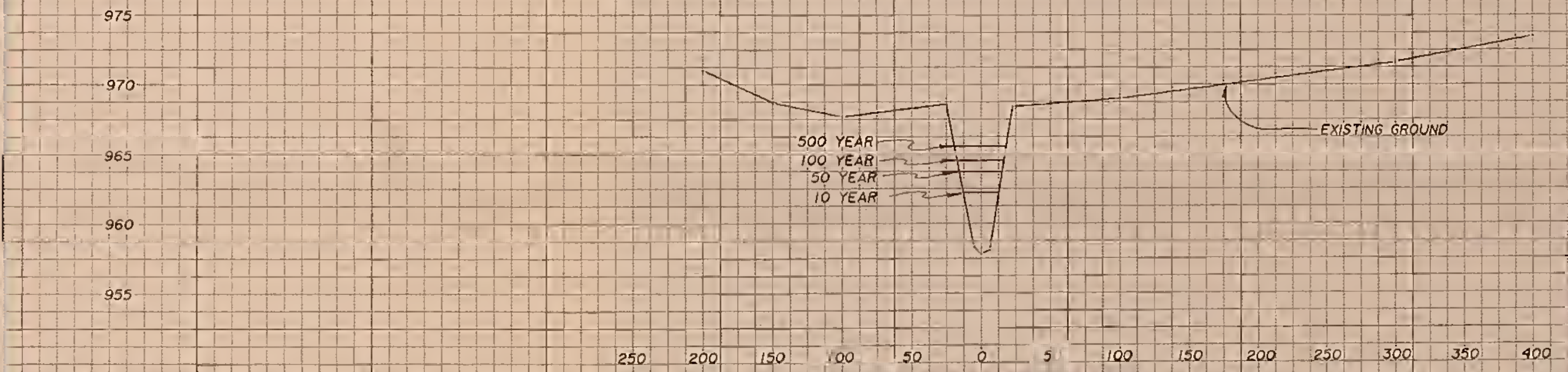
COLD CREEK

DISTANCE (in feet)



SECTION 15.5 -- STATION 257+14

COLD CREEK



SECTION 22.7 -- STATION 74+50

COUNTY DRAIN #15

TYPICAL VALLEY SECTIONS

COLD CREEK
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed: T.D. BOURDON	Approved By
Drawn: L.A. WILSON	
Checked: R.H. BAUERLE	Sheet No. 1 of 1

APPENDIX C

TABLE 1 - FLOOD DISCHARGES
COLD CREEK FLOOD PLAIN MANAGEMENT STUDY

Location	TR-20 Sec.	From Sec.	To Sec.	Drainage Area	Estimated Peak Discharges 10-Yr.	50-Yr.	100-Yr.	500-Yr.
				Sq. Miles	-Cubic Feet Per Second-			
COLD CREEK								
To Upstream of I-69	019	17.1	15.5	5.90	560	870	995	1470
To Confluence County Drain No. 15	021	15.1	13.5	8.35	805	1250	1430	2105
To Michigan Road	023	13.2	12.9	10.99	880	1410	1610	2375
To Marshall Street	026	12.5	11.9	13.58	945	1520	1750	2640
To Randall Lake	034	11.85	10.5	18.37	985	1610	1840	2770
COUNTY DRAIN NO. 15								
To Private Drive (CS 26.5 @ Sta.152+00)	001	26.7	26.5	0.11	25	40	50	75
To Michigan Road	003	26.1	24.9	0.83	125	195	225	335
To Below Seeley Road	006	24.5	22.5	1.16	150	240	275	380
To Michigan Road	009	22.1	21.9	1.71	190	315	360	520
To Confluence Cold Creek	014	21.5	20.5	2.64	305	450	505	705
LOWER LAKE CHAIN 1/		-	-	173.3	1395	1910	2115	2900

1/ Discharges from Coldwater River Flood Plain Management Study, May 1988. Used to establish the lake levels shown on photomaps 1 and 2 in Appendix A.

TABLE 2 - FLOOD ELEVATIONS AT SECTIONS
COLD CREEK FLOOD PLAIN MANAGEMENT STUDY

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
COLD CREEK						
	- 1/	0+00	926.3	927.2	927.5	928.6
	10.5 1/	15+20	926.3	927.2	927.5	928.6
	10.9 1/	44+70	926.3	927.2	927.5	928.6
Union City Road	11.0 D 2/	45+35	926.3	927.2	927.5	928.6
	11.0 U	46+01	927.3	927.8	928.2	929.5
	11.1	46+70	927.3	927.9	928.3	929.6
	11.5	73+22	927.7	928.4	928.8	930.1
	11.7	99+66	929.1	930.0	930.3	931.5
	11.75	112+05	932.5	933.6	933.8	934.7
Crossing at Gravel Pit	11.8 D	112+65	932.6	933.7	933.9	934.9
	11.8 U	113+05	932.7	933.8	934.0	935.0
	11.85	113+35	932.7	933.8	934.0	935.0
	11.9	141+80	933.4	934.4	934.7	935.7
Marshall St. (Old 27)	12.0 D	142+45	933.4	934.4	934.7	935.7
	12.0 U	143+11	933.8	934.9	935.1	935.9
	12.1	143+80	933.9	934.9	935.1	935.9
	12.5	182+00	939.8	940.8	941.0	942.0
	12.9	212+00	944.0	944.8	944.9	945.7
Michigan Road	13.0 D	212+67	944.1	944.8	945.0	945.8
	13.0 U	213+33	944.4	945.5	945.6	946.8
	13.1	213+75	944.4	945.5	945.6	946.8
Confluence at County Drain No. 15	13.2	217+67	945.4	946.2	946.3	947.3
	13.5	227+60	948.5	949.0	949.2	950.0
	13.9	236+25	952.9	953.8	954.3	955.4
I-69	15.0 D	238+55	953.4	954.4	954.8	956.0
	15.0 U	241+65	954.4	956.3	957.0	959.4
	15.1	242+00	955.1	956.8	957.4	959.7
	15.5	257+14	958.8	959.8	960.2	961.7
	15.6	266+68	960.6	961.6	961.8	963.1
Field Bridge	15.7 D	266+98	960.7	961.7	961.9	963.2
	15.7 U	267+38	960.8	961.8	962.1	963.4
	15.8	267+68	960.9	961.8	962.1	963.4
	15.9	277+82	962.0	962.7	962.8	963.8
Jonesville Road	16.0 D	278+49	962.1	962.7	962.9	963.9
	16.0 U	279+15	962.3	963.2	963.4	964.4
	16.1	279+82	962.4	963.2	963.5	964.5
	16.5	284+72	962.6	963.4	963.6	964.6
	16.9	294+82	962.7	963.5	963.8	964.7

TABLE 2 - FLOOD ELEVATIONS AT SECTIONS
COLD CREEK FLOOD PLAIN MANAGEMENT STUDY

CONTINUED

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
COLD CREEK-Continued						
Gorbell Road	17.0 D	297+09	962.8	963.6	963.8	964.8
	17.0 U	297+75	962.9	963.8	964.0	964.9
	17.1	299+22	963.0	963.8	964.0	965.0
COUNTY DRAIN NO. 15						
Confluence at	-	0+00	945.4	946.2	946.3	947.3
Cold Creek	20.5	21+20	949.0	949.8	950.1	951.1
	20.9	34+94	954.7	955.6	955.9	956.5
Newton Road	21.0 D	35+91	955.1	956.0	956.2	957.0
	21.0 U	36+47	957.9	960.1	961.0	963.6
	21.5	38+69	958.0	960.1	961.0	963.6
Michigan Road	22.0 D	42+91	958.2	960.3	961.1	963.6
	22.0 U	43+59	959.5	962.0	963.2	964.2
	22.1	44+75	959.5	962.0	963.3	964.2
	22.5	52+30	959.8	962.1	963.3	964.3
	22.7	74+50	962.2	963.7	964.5	965.5
	22.9	96+65	964.5	965.7	966.2	967.1
State Road	23.0 D	97+42	964.6	965.7	966.2	967.2
	23.0 U	97+88	966.1	967.8	968.6	970.2
	23.1	98+65	966.1	967.8	968.6	970.2
	23.5	106+65	966.2	967.9	968.6	970.3
	23.9	111+15	966.4	968.0	968.8	970.4
Private Road	24.0 D	111+99	966.4	968.1	968.8	970.4
	24.0 U	112+31	966.5	968.1	968.8	970.4
	24.1	113+15	966.6	968.1	968.8	970.4
	24.5	121+35	966.8	968.2	968.9	970.4
	24.9	129+00	967.9	969.0	969.5	970.8
Seeley Road	25.0 D	130+74	968.0	969.1	969.6	970.8
	25.0 U	131+10	968.6	970.1	970.7	971.9
	25.1	131+92	968.7	970.1	970.7	971.9
	25.9	138+97	970.1	971.1	971.6	972.7
Michigan Road	26.0 D	142+15	970.7	971.6	972.1	973.1
	26.0 U	142+79	971.6	973.1	973.7	974.5
	26.1	143+47	971.7	973.2	973.8	974.5

TABLE 2 - FLOOD ELEVATIONS AT SECTIONS
COLD CREEK FLOOD PLAIN MANAGEMENT STUDY

CONTINUED

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
COUNTY DRAIN NO. 15-Continued						
Private Road	26.5 D	151+60	971.8	973.2	973.9	974.7
	26.5 U	152+40	971.9	973.3	974.0	974.7
	26.7	161+00	971.9	973.4	974.0	974.7
LOWER LAKE CHAIN 3/	-	-	926.3	927.2	927.5	928.6

1/ Elevations controlled by backwater from Randall Lake (see Footnote 3).

2/ D and U represent downstream and upstream faces of bridge.

3/ Elevations from Coldwater River Flood Plain Management Study, May 1988.

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APPENDIX D

INVESTIGATIONS AND ANALYSES

Survey Procedures

Field surveys were made of bridges, roads, structures, channels and flood plains of Cold Creek and its southern tributary, County Drain No. 15, by the Soil Conservation Service in 1990. Temporary bench marks based on U.S. Department of Commerce, Coast and Geodetic Survey mean sea level elevations datum of 1929 were also set at this time and used for this study. In addition, several temporary bench marks set by the city of Coldwater were used. Surveys were made using second order accuracy. Temporary bench marks are described in Appendix E of this report.

For Cold Creek and its southern tributary, County Drain No. 15, 41 valley and channel cross-sections plus 15 roads, bridges and structures were surveyed. Aerial photography flown in 1989 by Abrams Aerial Survey was used as a base for the photo mosaic sheets used to delineate the flood plains. U.S. Geologic Survey 10-foot contour topographic maps were used to extend valley cross-sections.

Hydrology and Hydraulics

Physical data were obtained from U.S. Geologic Survey topographic maps, soil survey maps, local topographic maps and aerial photographs, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 12 sub-watershed areas for use in evaluating the runoff volumes. Drainage areas for the sub-watersheds were measured from U.S. Geologic Survey topographic maps. Times of concentration were calculated for the sub-watersheds using the Michigan Department of Natural Resources' UD-21 method. Each sub-watershed was evaluated for land use, cover and soils. Runoff curve numbers were calculated.

Channel flood routings to establish peak discharge-frequency relationships were made using the PC version of the Soil Conservation Service's TR-20 Hydrology Computer Program dated September 1, 1983. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships. The TR-20 computer program used the storage indication method of evaluating the effect of a large wetland at the outlet of sub-area 5 above I-69 in reducing peak flood discharges into County Drain No. 15. Table 1, Appendix C, lists discharges obtained from the flood routings and Table 2, Appendix C, lists flood elevations at sections located in the study area.

Information from the U.S. Geologic Survey stream gage at Hodunk and U.S. Geologic Survey Water Supply Paper 1677 were used to verify peak discharges below the Lower Lake Chain as determined by the TR-20 model. Peak discharges from the TR-20 model for the 100-year, 50-year and 10-year storms were within 5 percent of the observed discharges. Within a few days of the May 30-31, 1989 flood, the Soil Conservation Service located several high water marks along Cold Creek and its southern tributary, County Drain No. 15. On May 30, 1989, 4.48 inches of rainfall fell in Coldwater, Michigan and on May 31, 1989, 3.45 inches fell. Water surface profiles for the computed 24-hour 500-year flood were within one foot of the actual flood elevations.

Documentation for the investigation and analysis of the Lower Lake Chain can be found in the May 1988 Coldwater River Flood Plain Management Study Technical Report Supporting Documentation. The Lower Lake Chain drainage area is approximately 174 square miles. The TR-20 flood routing program was used to determine inflow hydrographs. Outflow hydrographs for discharge out of the lakes were based on elevation-discharge relationships developed by the WSP-2 water surface profile program and TR-20 flood routing program. A starting lake elevation of 924 feet was used to model existing conditions. Table 1, Appendix C, lists discharges obtained from the flood routings and Table 2, Appendix C, lists lake elevations.

Water surface profiles for Cold Creek and its southern tributary, County Drain No. 15, were developed using the Soil Conservation Service's WSP-2 computer program. This program uses the step method of computation to solve the Bernoulli equation and the Bureau of Public Roads' bridge loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles along the channels. Manning's "n" values were determined from field investigations of the channels and flood plains.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage area and land use and cover, will require recomputation of water surface profiles.

Flood plain delineations were made on the contour maps and photomap sheets. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Limits of flooding shown on the photomaps may vary from actual location on the ground, and the photographic image may vary from true ground location due to inherent aerial photograph displacement. Flood plain delineations around the Lower Lake Chain, shown in Appendix A (photomaps 1 and 2), are based on the computed lake levels described in the May 1988 Coldwater River Flood Plain Management Study Technical Report Supporting Documentation. This report does not include plotted profiles for Maps 1 and 2, but the appropriate flood elevations are shown at section 10.5 on the Cold Creek Profile Sheet. Wave action may cause flooding of additional areas. In addition, road fills with inadequate or no crossings may be causing some flooding above the roads. These areas were not delineated in this study. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

Where the limits of the 500-year and 100-year floods were too close to delineate, the limits of the two flood plains are shown as the same line on the photomap sheets.

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APPENDIX E

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

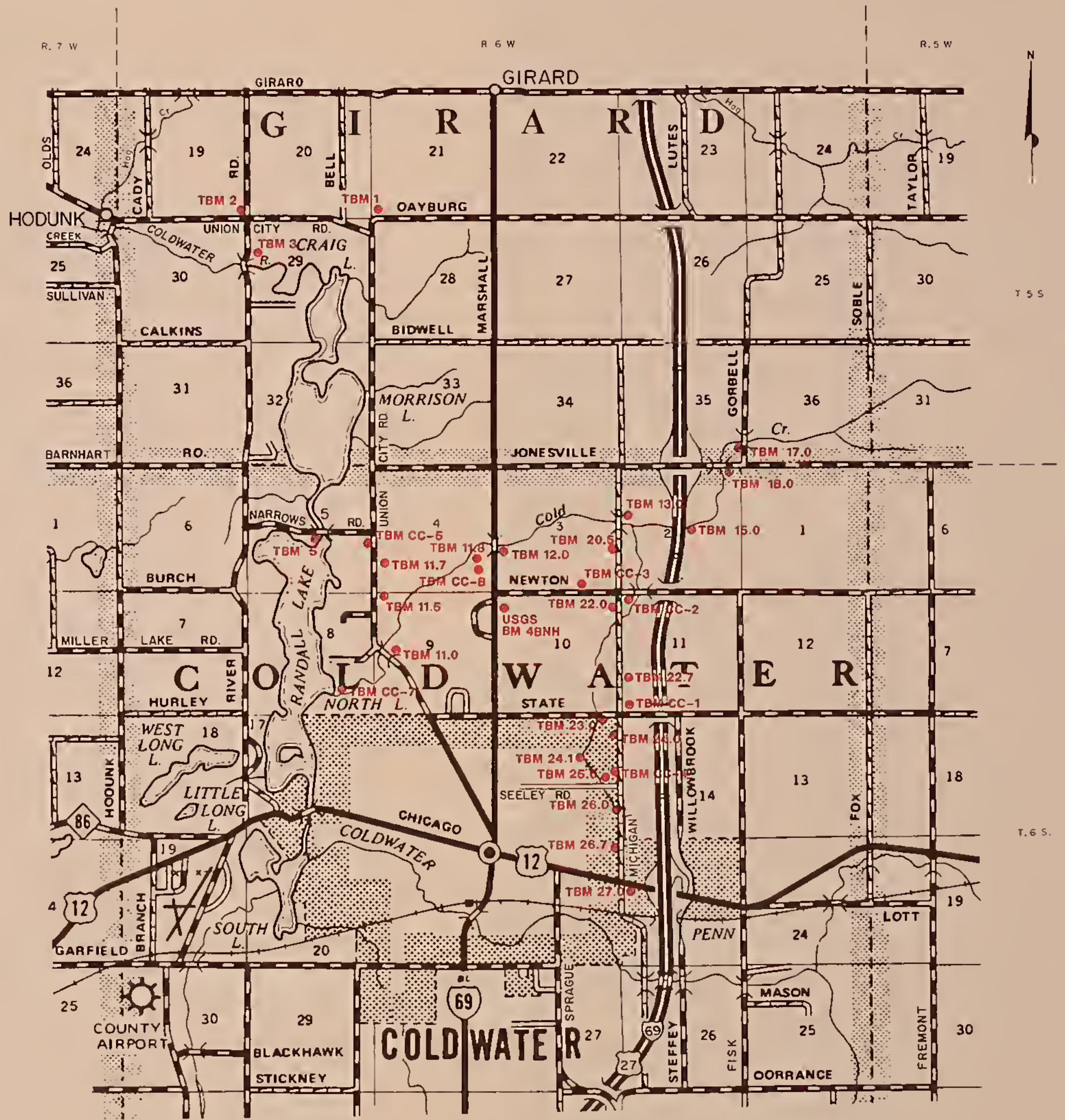

FIGURE 3

BENCH MARK LOCATION MAP
Cold Creek

FLOOD PLAIN MANAGEMENT STUDY

BRANCH COUNTY, MICHIGAN

Approximate Scale - Miles

Approximate Scale - Kilometers

BASE COMPILED FROM MICHIGAN COUNTY HIGHWAY MAP.

AUGUST 1991 1005842-03

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH TX 1992

BENCH MARK DESCRIPTIONS *

COLD CREEK AND TRIBUTARY

BRANCH COUNTY, MICHIGAN

BM USGS 49NH 1958

Section 10, T6S, R6W - Approximately 450 feet south of the intersection of Newton Road and Old 27 (Marshall), approximately 32 feet east of centerline of Old 27, approximately 1 foot west of property line fence. A bronze disk (USGS) stamped "49 NH 1958" and set in the top of a concrete post approximately 4 inches above ground.

Elev. 978.995

TBM 1

Section 21, T5S, R6W - SCS Spike and disk in CP power pole north of 90° turn in Dayburg Road, near the intersection at River Road and Union City Road.

Elev. 941.23

TBM 2

Section 19, T5S, R6W - SCS spike and disk in CP power pole #35-4-35.

Elev. 937.23

TBM 3

Section 29, T5S, R6W - SCS spike and disk in telephone pole #100GT approximately 200 feet north of River Road Bridge, east side of River Road directly east of farm house.

Elev. 936.72

TBM 5

Section 5, T6S, R6W - Off southwest corner of Narrows Street Bridge. SCS spike and disk in power pole #MO-75, SPG 5-30.

Elev. 937.78

- - - - - - - - - - - -

* Elevations based on USC and GS mean sea level datum of 1929.

TBM 11.0

Section 9, T6S, R6W - Approximately 3 feet upstream of S.E. corner of the Union City/Battle Creek Road Bridge over Cold Creek. Chiseled X on top of poured concrete retaining wall on south bank.

Elev. 926.19

TBM 11.5

Section 9, T6S, R6W - Approximately 2700 feet south of the intersection of Union City Road and Narrows Road, approximately 30 feet east of center of Union City Road between house #990 and 996. 8d doublehead nail in SCS disk approximately 2 feet above ground in power pole.

Elev. 942.86

TBM 11.7

Section 4, T6S, R6W - Approximately 1200 feet south of the intersection of Narrows Road and Union City Road, approximately 30 feet east of the center of Union City Road in power pole #900 at house #1112. 8d doublehead nail in SCS disk 2 feet above ground in west side of power pole.

Elev. 948.05

TBM 11.8

N 1/2 of SE 1/4 of Section 4, T6S, R6W - Approximately 12 feet east of the chimmey at the northwest corner of a concrete block building (abandoned concrete batch plant) approximately 100 feet east of Cold Creek. Chiseled X in top of concrete pier poured inside a 55 gal. metal drum supporting an I-beam post for a metal canopy.

Elev. 932.23

TBM 12.0

Section 3, T6S, R6W - Approximately 2300 feet north of the intersection of Old 27 and Newton Road at Old 27, Marshall Bridge over Cold Creek. Chiseled X on concrete headwall at the southeast corner of the bridge, approximately 3.5 feet below road surface.

Elev. 931.20

TBM 13.0

Section 2, T6S, R6W - At Michigan Road bridge over Cold Creek approximately 3,000 feet north of Newton Road. Chiseled X on a 4-inch wide ledge approximately 18 inches below the top of the concrete headwall at the northeast corner of the bridge.

Elev. 944.99

TBM 15.0

Section 2, T6S, R6W - At southeast corner of upstream headwall for twin cell box culvert for Cold Creek under I-69 at Jonesville Road. Chiseled X at the center of the top of the 6-inch thick headwall at outlet of 15-inch diameter drainage conduit.

Elev. 952.45

TBM 16.0

Section 2, T6S, R6W - Approximately 1,100 feet east of I-69 on the Jonesville Road bridge over Cold Creek. Chiseled X approximately 2 feet south of the southeast corner of the bridge on 10-inch wide ledge approximately 3 feet below the top of the headwall.

Elev. 961.72

TBM 17.0

Section 35, T5S, R6W - On the downstream headwall at the box culvert for Cold Creek under Gorbell Road approximately 1,100 feet north of Jonesville Road. Chiseled X on top of concrete headwall at southwest corner of the structure.

Elev. 963.84

TBM 20.5

Section 3, T6S, R6W - Along Michigan Road approximately 1,850 feet north of Newton Road. On crown at the next to last corrugation at the west end of a 18-inch diameter corrugated metal pipe culvert.

Elev. 958.07

TBM 22.0

Section 10, T6S, R6W - Approximately 27 feet west of the center of Michigan Road approximately 450 feet south of Newton Road. On culvert crown at the next to last corrugation at the west end of the 96-inch diameter corrugated metal pipe that carries the flow of County Drain No. 15.

Elev. 961.18

TBM 22.7

Section 11, T6S, R6W - Approximately 27 feet east of the center of Michigan Road and approximately 1,400 feet north of State Road. On culvert crown at the next to last corrugation at the east end of a 30-inch diameter corrugated metal culvert.

Elev. 984.66

TBM 23.0

Section 15, T6S, R6W - Approximately 30 feet south of the center of State Road, approximately 27 feet east of the road culvert that carries the flow of County Drain No. 15, approximately 1,320 feet west of Michigan Road. 8d doublehead nail in SCS disk approximately 5 feet above ground in the north side of power pole.

Elev. 971.49

TBM 24.0

Section 15, T6S, R6W - Approximately 30 feet west of the center of Michigan Road, approximately 800 feet south of State Road. 8d doublehead nail in SCS disk approximately 6 inches above ground in the west side of a 48-inch diameter forked oak tree.

Elev. 984.41

TBM 24.1

Section 15, 76S, R6W - Approximately 30 feet west of the south end of a culvert under a private road, approximately 1970 feet west of Michigan Road and 1340 feet south of State Road. Top of 12-inch square concrete gate post.

Elev. 971.33

TBM 25.0

Section 15, T6S, R6W - In north side of second guard rail post from the east on the north side of Seeley Road, approximately 20 feet east of a culvert, approximately 500 west of Michigan Road. 8d doublehead nail in SCS disk approximately 16 inches above ground.

Elev. 973.70

TBM 26.0

Section 15, T6S, R6W - At the southwest corner of the concrete box culvert under Michigan Road approximately 300 feet north of Smith Street. Chiseled X on top of wingwall approximately 6 inches west of downstream headwall.

Elev. 977.09

TBM 26.7

Section 22, T6S, R6W - At fire hydrant along west side of Michigan Road approximately 300 feet north of Orleans Boulevard. On top of 6-inch diameter spigot on east side of hydrant.

Elev. 976.80

TBM 27.0

Section 23, T6S, R6W - At the southeast corner of the intersection of Chicago Road and Michigan Road. 8d doublehead nail in SCS disk 2 feet above ground in the southwest side of new power pole.

Elev. 976.98

TBM CC1

Section 11, T6S, R6W - At the northeast corner of the intersection of Michigan Road and State Road. On exposed reinforcing rod in top of concrete right of way marker.

Elev. 999.43

TBM CC2

Section 11, T6S, R6W - At the southeast corner of the intersection of Michigan Road and Newton Road. On 2-inch diameter iron gate hook 4 inches above ground on the west side of a concrete corner post.

Elev. 963.56

TBM CC3

Section 3, T6S, R6W - Approximately 33 feet north of the center of Newton Road and approximately 50 feet east of a culvert under Newton Road or approximately 1,670 feet west of Michigan Road. 8d doublehead nail in SCS disk approximately 2 feet above ground in the south side of a 14-inch diameter walnut tree.

Elev. 964.25

TBM CC4

Section 15, T6S, R6W - Approximately 25 feet west of the center of Michigan Road, approximately 300 feet north of the Seeley Road intersection. 8d doublehead nail in SCS disk in west side of 40-inch diameter oak tree.

Elev. 974.70

TBM CC5

Section 5, T6S, R6W - Along the west side of Union City/Battle Creek Road approximately 150 feet south of the intersection with Narrows Road. 8d doublehead nail in SCS disk 2 feet above ground in second power pole south of intersection.

Elev. 946.70

TBM CC6

N 1/2 of SE 1/4 of Section 4, T6S, R6W - At center of the 12-foot wide door on the north side of the 40 x 160 concrete block building, approximately 600 feet east of Cold Creek. Chiseled X on concrete threshold.

Elev. 936.12

TBM CC7

Section 8, T6S, R6W - Approximately 230 feet south of the center of Bonnie Lane across from house #43, approximately 25 feet N-NE of the southeast corner of a chainlink fence on north bank of Cold Creek. On top of 1-inch diameter metal pipe.

Elev. 925.31

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APPENDIX F

GLOSSARY

BACKWATER--The resulting highwater surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK--Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE--The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL or WATER COURSE--An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM--The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE--A flowing together or place of junction of two or more streams.

CROSS-SECTION or VALLEY SECTION--A graph showing the shape of the stream bed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM--An assumed reference plane from which elevations and depths are measured, such as from sea level.

ELEVATION-DISCHARGE RELATIONSHIP--The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD--A temporary overflow by a river, stream, ocean, lake or other body of land not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated areas attributable to pollutants, debris and water table.

FLOOD CREST--The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY--A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 10 years. It has a ten percent chance of being equaled or exceeded in any given year.

100-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 100 years. It has a one percent chance of being equaled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

FLOOD PEAK--The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN--The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD-PRONE AREA--Areas that experience ponding due to high water table soils and/or inadequate outlets.

FLOOD ROUTING--The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE--The elevation at which overflow of the natural stream banks or body of water occurs.

FLOODWAY--The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE--The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS--The effect of obstructions; such as narrow bridge openings, dams or buildings; that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER--The tributaries and upper reaches which are the sources of the stream.

HIGH WATER or FLOOD PROFILE--A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

HYDRAULICS--The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH--A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY--The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION--The flooding or overflow of an area with water.

LEFT BANK--The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND--The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n"--A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH--A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK--The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW--The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF--That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

TIME OF CONCENTRATION--Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED--A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY--The divide separating one drainage basin from another.

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APPENDIX G

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